INTEGRATION OF VIRTUAL PLAYERS INTO A PEDAGOGICAL SIMULATOR

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Abstract

The development of learner activity is a key element in the improvement of ITS (Intelligent Tutoring Systems). In business simulation, the learner is stimulated by competition with other learners. In practice, it is not always possible to find enough participants, hence the idea of virtual player participation. The SIMPLUS system proposes a generic approach to this end and creates virtual players within a business simulation without modifying the simulation itself.

INTRODUCTION

The development of learner activity is a key element in improving human training environments. Learner activity which simply involves clicking on hypertext links or answering multiple choice questions is obviously not satisfactory. There are several ways to improve learner activity. On the one hand, the networks enhance communication among learners and also with the tutor whose role is recognised as being highly important. On the other hand, it is important that, whenever possible, the learner be engaged in problem-solving activity involving real interactivity. This indeed is the case when the ITS includes a solver developed through Artificial Intelligence, an environment based on micro-world, virtual reality or a simulator (Guéraud et al. 99).

Working in the context of a RIAM project named SIMPLUS and in collaboration with an industrial partner EXOSIM, we focused on business games, a simulation activity which is widely used at college level (particularly in engineering and business schools) to train students in company management. The aim of our industrial partner is to provide a large set of business games on line in an ASP context. This environment is described in the following paragraph. The focus of our work in the SIMPLUS project is to improve the "playability" of these business games by the possibility for the tutor in charge of the simulation to introduce virtual players into the game. To make the game appealing, more than eight teams are required. Lastly, as we are in an industrial context, it is obvious that we are not trying to define virtual players for one particular game but rather for a host of games. The aim of the project is thus to build, from experience, a general methodology for designing virtual players.

Section 2 provides a general description of a multi-player simulation game that can be used on line. Section 3 outlines a process for developing virtual players, and Section 4 a process for designing them. Finally, the epiphytic character of the virtual player is presented in Section 5.

AN ONLINE BUSINESS SIMULATION GAME

General description of a multi-player simulation game on the Web

EXOSIM has developed an online business-simulation game. Two websites have been created: one for the players and the other for arbitration. The first site presents all the services of the game: participation in the contest, presentation of the results, comments, e-mails and FAQ. The second site is accessible only to the referees.

Initially, the referee plays the role of organiser: he defines the simulation according to different scenarios, fixes the complementary parameters and manages the simulation (data processing, virtual players …). Secondly, he plays the role of tutor: he analyses the decisions and the results of the teams, gives them advice and also answers the e-mailed questions. As Crampes and Saussac (99) wrote, “the choice of the scenario and the technical and human organisation are fundamental to achieve this goal”. Concerning the technology developed in HTML and ASP, the sites run on a SQL Server database (Vaughn W., 1996) and a simulation engine developed using Visual Basic.

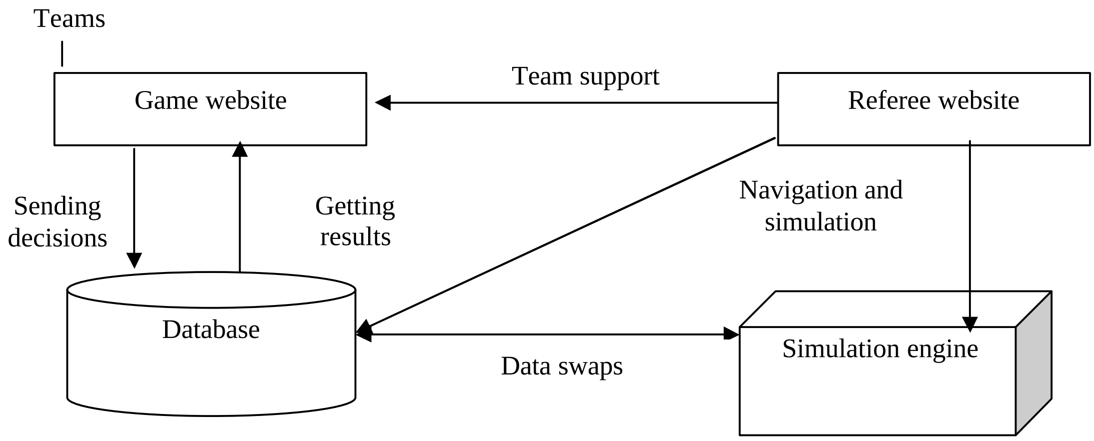

Figure 1. The global system

Visual-Surf, a business-simulation game

Visual-Surf is an online simulation game developed by EXOSIM. It is a business game involving a wintersports-material company. The game has two facets: a website game itself which allows the participants to play, and an arbitration website which allows the referee (in other words the tutor) to parameterise the simulations.

Each team represents a company producing snowboards, funboards and surfboards. The game is composed of ten periods, each corresponding to a business year for the company. In each new period, the playing team must make a general decision about different parameters of the company before a deadline which is determined at the beginning of the simulation.

This decision is composed of production decisions (management of the production equipment), commercial decisions (management of the commercial and marketing parameters of the company), and financial decisions (budget and portfolio management). During the game it is possible for the teams to communicate with each other and also with the referee. In this way, the referee can advise the teams, and the teams can exchange information relevant to subcontracting and tendering (take-over bids).

At the end of each period, the results of the period are sent to the companies together with the referee’s comments. The results obtained give a broad outline of the company and its competitors. These results belong to different categories: general results common to all the companies (market share per product and company; average investment by company in advertising, research, quality, organisation and maintenance; average price by product for all companies…); accounting results which are specific to each company (income statement; assessment; details of stock by product in volume and value); production results specific to each company (management of the production equipment: assignment of production units, detailed cost price; calculation of the production cost of the products).

The teams are divided into several groups and, after the last period, a winner is designated on the basis of his score. Apart from the first decision, there are three sources of information for the player: the historical logfile of the past decisions, present results of the team and its competitors, and a market study provided by the system. From this information the player can define his own strategy and plan a new decision. As described below, the virtual player uses the same data to make his decision.

DEVELOPMENT PROCESS of the VIRTUAL PLAYER:

Argumentation

It is well known that to explicit the expertise is the bottleneck for the development of expert systems, specially when the goal is to model humans. But, in the case of simulation, we are in a very propitious situation as the expertise of good players is represented within the simulation engine in a procedural manner. So, what we have to do, is only to represent this expertise in a declarative manner. Moreover, as human players are represented into the database with attributes, we use the same attributes to describe them into the expert system, using the Clips "template" (CLIPS, http 03). These two points are the key points when defining the project.

Stages

Stage 1: Analysing the game

The main objective of the project is to create virtual players which can be used in several simulations. However, each simulation has its own characteristics (game rules, team organisation…). It is thus necessary to assimilate the simulation environment and also to define the general aspect of the virtual player in order to define the modelling framework of his physical entity and his behaviour. This stage makes it possible to answer the fundamental questions which are raised by the creation of the virtual player: In which environment does the virtual player operate? What are the rules of the game? What are the strategies of the game? How should he play?

Stage 2: Modelling the decision-making

The aim of this stage is to build a general outline of a player's decision-making based on two identification processes: identification of the various stages of the decision (which makes it possible to define the way to be followed by the virtual player to make his decision) and from a more specific point of view, identification of the decision variables of each stage, which makes it possible to define the numerical parameters to be determined by the virtual player. Modelling was done according to the UML method. The virtual player was constructed in two modules in order to define a reliable game behaviour: the first module represents the decision making of the player and the second the procedural aspect; i.e. how the simulation engine computes the parameters.

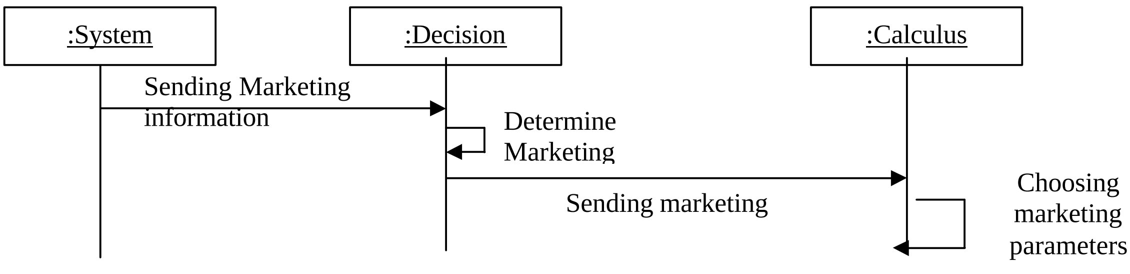

Figure 2. An example of UML Models

Stage 3: Designing of the software architecture

The data generated by the decision-making of the human players are stored in a database and are treated later by the simulation engine. Analysis of these data makes it possible to determine the relevant tables and the right attributes representative of the player's decision and to transform them into an object structure within the expert system. From this analysis and from the analysis of the functions used by the simulation engine, it is possible to define two kinds of functions: calculation functions which will be reproduced in the expert system just as they are in the simulation engine, and the functions which model the expertise (identification of the parameters of the functions and extraction of the limit values used by the engine to define the different behaviours of the player).

For example, when the player determines his cost price, he should first of all set certain parameters such as publicity. Let X be, the value of the parameter publicity fixed by the player, and Y(x) the value of a marketing variable calculated by the engine from publicity, the simulation engine uses an interval of value [Ymin, Ymax] to which must belong Y(x): if Y(x)>Ymax then Y(x)=Ymax. When these parameters are set, the cost price is automatically calculated by calling upon calculation functions which require no decision.

Stage 4: Creation of the virtual player

Once the information necessary for the decision-making has been determined, it is now necessary to develop the expert system representing the player. It must meet the needs defined in stage 1 and present different possible behaviours: aggressive, neutral and fearful. The expert system is described in paragraph 4.

Stage 5: Integration of the expert system

The technologies used in the management of the human players and those used in the creation of the expert system are different. It is thus necessary to integrate the expert system into the game of simulation. The communication between the virtual player (developed using CLIPS) and the data-processing architecture of the simulation game can be carried out in the form of DLL (Dynamic Link Library). The data generated by the virtual player are transmitted to the database in the same way as for the human players.

DESIGNING THE VIRTUAL PLAYER

General characteristics of a virtual player

If the virtual player's behaviour is too different from that of the human player's, the simulation will lack in appeal; this will not only detract from the playability of the game but will also, probably, divert the students from the subjacent objective which is to acquire concepts of business management. It is thus essential that the virtual players be accepted by the human players. Bearing this in mind, it is necessary that they have the following characteristics:

1. They must play in a normal way, neither too well nor too poorly. This, however, is not necessarily easy to arrange. If the games are simple, for example if they are algorithmic in nature, the virtual players can play perfectly. On the other hand, if the games require real expertise, the virtual players may have aberrant behaviours, in particular when they are designed along symbolic lines.

2. Their behaviour must be unpredictable so that, in identical situations, the human players cannot anticipate their reactions. This is *a priori* easier to arrange (you just need to introduce more randomness into the game). However, in most games (console games) the behaviour of the virtual players is completely stereotyped which means that their human adversary can learn their reactions “by heart”. In addition to making the game more random, it is possible to define several categories of virtual players, as we have done in this project.

3. They must not "cheat". On the one hand, if the human players notice that the virtual players are not playing fair, they will probably feel distaste for the game; moreover, this cheating can hinder the training. Indeed, if the virtual players are efficient because they possess information which they are not supposed to have, the learners may make false conjectures about

the virtual player's reasonings[1]. Consequently, they must be no doubt about the information available to the virtual players. In this particular case, the virtual players have the same information as the human players, but the expertise model they contain is the same as the model which is implanted in the simulation. This is one of the fundamental ideas of this project: collecting the expertise of a field is not difficult insofar as, by definition, this expertise is in the simulation engine.

Creation of the virtual players

To meet the different needs of a simulation, the virtual players were designed as an expert system (SE). The expert-system approach was the obvious choice as it can represent a true game rationality: i.e., adapt the decision to the economic situation in the game (company results, market trends etc.), evolution of the decision-making (change of strategy or behaviour during the game)… Thus the virtual player is not simply a calculus algorithm. He is a module composed of a set of objects and rules, a module which sets the numerical parameters of the virtual player's decision.

The expert system operates in the same way as the human player with his calculus sheet and his decision sheet. It finds all the necessary information for decision-making (results of the previous period and parameters of the current period), it processes it and sends the numerical data of the new decision to the database. The expert examination of the game expressed in declarative form allows rules to be added and modified which means that the player can operate successfully, and also that he can adapt to different simulation games.

One of the objectives in the development of the virtual player was to be able to choose between different game attitudes.

A fearful player: He is prudent in his approach towards market shares and never takes great risks while managing his company. Thus, he arranges things so that he will not borrow too much and always keeps enough factories. He invests just the right amount in research. With regard to prices, he always sets high margins in order to be on the safe side.

A neutral player: He is typically average. He invests just the right amount in research; he produces neither too much, nor too little. He sets margins that are not particularly high but not very low either. Finally, the neutral player does not have any ambition.

An aggressive player: He is the complete opposite of the fearful player. He aims to get the highest market share, he accepts large loans and small margins in order to crush competition. He invests huge amounts to be sure to produce surfboards as soon as possible.

These three types have been described by coefficients which are internal to the expert system. These coefficients are based on calculations relative to the decision and on the threshold values of the simulation engine. These values determine intervals to which the results of the decision made by the player belong: the aggressive player is close to the upper limits and the fearful player to the lower limits.

The test interface made it possible to test the performances of the expert system compared to the decisions made by the players whose strategies were similar to the three behaviours defined above. The tests were carried out on three types of periods, each of which has a specificity in the time-course of the game: the tests of the period 1 type were chosen as they involve the initialisation of the simulation, the tests of the period 2 type because the companies cannot yet produce all the products (they are no surfboards), and the tests of the period 7 type because the companies which have completed their research phase can produce surfboards. Initially, each player (fearful, neutral and aggressive) was tested over these periods in the CLIPS environment. After that, the test interface was used to test them in the simulation environment. The results

[1] This can be seen in computerized bridge games which use knowledge of the four deals to play the cards. This leads to aberrant behaviour (for instance, making a useless finesse because the players know it will work).

showed that the expert system took into account the various behaviours in a random way: a fearful player never made the same decision in two consecutive episodes, and this was true for the two other types of players as well.

AN EPIPHYTIC VIRTUAL PLAYER

The development process made it possible to define an evolutionary expert system. Such a structure should enable the virtual player to adapt to various phases of the game, but also to various simulations of the business game. In order to adapt to several simulations, the virtual player must be able to integrate easily into the online game.

The expert-system approach respects these criteria: the CLIPS module is integrated into the data-processing environment of the decision through a DLL enabling the virtual player to communicate with the database and also with the website used by the referee (by this website, the referee can define the number of players, their behaviour and some global economic variables about the game). On the one hand, the expert system can easily be moved or modified in order to adapt to another simulation. On the other hand, its running does not interfere with the functioning of the game: the expert system must not modify the data processing of the simulation. *For human players* and *for the system*, there are no difference at all between the decisions taken by virtuals or real players: The same procedure enters the data into the database. The only difference comes from the fact that the procedure receive data from a form for the human players and from the expert system for virtual players. Thus, the virtual player can be described as an epiphytic system.

CONCLUSION

The development of the creation process of the virtual players uses reverse-engineering technology which is based on the expertise implanted in the simulation. Thus, it meets the virtual players' need for adaptation and evolution.

This approach is also complementary to the research work on the help system and on the evaluation of the learner in online business games. The decisions follow the same process both for the virtual player and for the human player. It is thus possible to use this process to establish a help system and a system to evaluate learner's skills, which will be developed in the future. As the virtual player uses the same calculation principles as the human player, if the human player wrongly sets the parameters of a decision, the help system can use these principles to recognise the unsuitable attitude of the human player and suggest a better attitude to him. Moreover, the help system does not have the same constraints as the virtual player (unlike the virtual player the help system can "cheat"); consequently, it can also use the operation of the engine and the limit values to improve the quality of the advice it given to the human player.

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